# COSE474-2024F: Final Project Proposal
# "Enhancing Semiconductor Defect Detection through Multi-modal Deep Learning Frameworks"

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## 1. Introduction

Semiconductor manufacturing is essential in electronics, where even minor defects can result in substantial financial losses. My growing interest in semiconductor processes, spurred by advancements from companies like NVIDIA, highlights the need for innovative defect detection. Current research underscores the effectiveness of deep learning, particularly Convolutional Neural Networks (CNNs), in automating defect detection (Cheng et al., 2021; Shinde et al., 2022). However, many methods overlook crucial process parameters necessary for accurate identification. This project aims to develop a multimodal framework integrating image data and process parameters to enhance defect detection accuracy. Key objectives include:
**Framework Development**: Integrate image and process data for better defect detection.
**Metrics Establishment**: Create quantitative evaluation metrics for model performance.
**Comparison with Techniques**: Benchmark against existing methods to highlight contributions.

## 2. Problem Definition & Challenges

The project seeks to create a multimodal framework that integrates image and process data to improve defect detection and classification.

Key challenges include low inter-class variation and high intra-class variation in defect images, complicating differentiation between defect types.

## 3. Related Works

Recent studies have explored deep learning applications in wafer defect detection, utilizing techniques like CNNs and YOLO for classification (Cheng et al., 2021; Shinde et al., 2022).

## 4. Datasets

The study will use the WM-811K dataset, comprising 811,457 annotated wafer images across various defect classes, providing a diverse sample set for training and evaluating the multimodal model.

## 5. State-of-the-Art Methods and Baselines

Recent advancements have emphasized various deep learning techniques enhancing classification accuracy and defect localization. For instance, YOLO frameworks have achieved high accuracy in real-time applications (Shinde et al., 2022). Hybrid approaches combining traditional algorithms with CNNs have also reduced false positives (Cheng et al., 2021).

Establishing robust baseline methods is essential for evaluating the proposed multi-modal framework's performance. This involves using standard metrics for clear comparisons with existing models and demonstrating improvements in generalization across defect types.

## 6. Schedule

During November,

Week 1: Literature review and dataset preparation
Week 2: Model development, preliminary experiments
Week 3: Performance evaluation and adjustments
Week 4: Final evaluation and report writing

## References

Cheng, K. C.-C., Chen, L. L.-Y., Li, J.-W., Li, K. S.-M., Tsai, N. C.-Y., Wang, S.-J., Huang, A. Y.-A., Chou, L., Lee, C.-S., Chen, J. E., Liang, H.-C., and Hsu, C.-L. Machine learning-based detection method for wafer test induced defects. *IEEE Transactions on Semiconductor Manufacturing*, 34(2):161–167, 2021. doi: 10.1109/TSM.2021.3065405.

Shinde, P. P., Pai, P. P., and Adiga, S. P. Wafer defect localization and classification using deep learning techniques. *IEEE Access*, 10:39969–39974, 2022. doi: 10.1109/ACCESS.2022.3166512.